

1. Project Summary

Locating educational courses in a distributed environment is a daunting task. This is made even more demanding when the courses have been subdivided into reusable models, as the number of objects rapidly increases. Metadata—searchable descriptions of the objects—supports this process. This report, sponsored by the Air Force Institute for Advanced Distributed Learning and funded by the Joint ADL Co-Lab, describes the process and findings of a project to develop guidelines and taxonomies to facilitate content reuse. The project's goal was to develop an appropriate set of metadata fields and the vocabularies and taxonomies to be used to populate those fields. Subsequent to the development of the metadata system, a metadata tool interface was to be developed using that system. The project method featured a meeting of course developers at several levels collaborating to define metadata and the rules for module reuse.

There are five significant outcomes from this project:

1. A set of defined metadata fields;
2. Value domains including three existing sources for the primary taxonomies;
3. Models and rules for module development and reuse;
4. Validation of methodology;
5. Prototype tagging tool.

The meeting methods may prove valuable to others in the development of metadata fields and taxonomies. It focused on real courses and modules; a concrete task to force fit a module into multiple courses, and the use of multiple independently tasked recorders. The discovery of existing resources for subject, application domain and proficiency level leads to the possibility of existing sources of taxonomies for other career fields. Team agreement on a common course structure model to support reusable modules was a surprising result. The metadata fields, value domains, and course structures model are compatible with SCORM and attest to the utility of the SCORM specifications. The method needs to be tested for replication, but offers a working model that can be used by the broader ADL community.

A Web-accessible functional metadata tagging and search tool was developed that communicated over the Web to the AFIADL's SCORM-compliant metadata repository. The tool is designed for reconfiguration in three aspects:

1. The user interface can be readily changed to reflect preferences. This may include fields normally used and their order of presentation, facilitating workflow integration.
2. The tool's internal metadata schema (e.g., SCORM 2004, SCORM1.2, AFIADL, and IEEE-LOM) may be changed easily through reference to an external schema.

3. The tool's communication format with the external repository may be changed through a separate mapping table. The ability to reconfigure the tool supports potential use beyond this project's target of AFIADL.

2. Project Tasks

The main project tasks are summarized below. Task descriptions are included with individual performance objectives from the Statement of Work (SOW). We have reproduced the numbering from the SOW to aid in cross-referencing this work to the original requirements.

2.1 Perform Field Ethnographic Study

Task 3.1.1 Description: Conduct a comprehensive Field Ethnographic study to develop domain-specific taxonomies that describe three Air Force specialty codes (AFSC).

Task 3.3.1 Description: Establish recommended object definitions and levels of granularity by systematically evaluating alternatives. Teaming with AFIADL, the contractor shall seek consensus judgments or ratings of merit of the alternatives in order to provide criteria for reasonable reliability and validity for future analysis.

Task 3.3.2 Description: Assess whether learning object boundaries and granularity for specific content can be derived or estimated using the taxonomic results, metadata, or methods used to establish technical data content objects including maintenance content complexity.

Task 3.3.3 Description: Assess whether reuse potential of specific content can be derived or estimated using the taxonomic results, metadata, or methods used to establish technical data content objects including maintenance content complexity.

This study was performed by Teleologic to define the metadata and taxonomies for AFIADL.

Boeing and Teleologic met with AFIADL in a Working Group Meeting on 14-15 January 2004 to discuss and explore Metadata and Taxonomies for AFIADL training.

This working meeting used four separate recorders for Terminology, Concepts, Metadata and Reusability. The format of this working meeting was very effective in discovering common terms and concepts and defining useful metadata.

The participants of this meeting found that a valuable taxonomy already existed, the Technical Ordering (TO) Numbering System. The Plan of Instruction (POI) defined the subject (i.e. Electronics) and the Proficiency Level defined the knowledge level, and whether performance or awareness is required. The TO Numbering System, the Subject and the Proficiency Level are the three major taxonomies defined for this effort.

See [Appendix A - AFIADL Metadata and Taxonomies: Working Group Meeting Report, 14-15 January 2004, Maxwell AFB](#), and its accompanying appendices (A.1-A.8), for detailed information.

Task 3.1.6 Description: Examine the Classification SCORM Meta Data Element and the Learning Object Metadata (general description or general keywords) as locations to implement the metadata derived from the taxonomic study.

See [Appendix B – Metadata Field Overlap](#) for information about potentially redundant metadata fields. The purpose of this document is to present some of the issues relative to the selection of metadata fields for AFIADL, and compares the initial AFIADL metadata with SCORM metadata.

See [Appendix C – AFIADL Metadata and Taxonomies, Fields, Taxonomies and Vocabularies](#) to view the initial metadata fields developed as part of this effort.

See [Appendix D – AFIADL Metadata Master](#) to view the final metadata fields defined during this project.

Task 3.1.7 Description: Work, as necessary, with DoD, W3 committee, and/or IMS to develop standards/ specifications relevant to these metadata.

Boeing and Teleologic are both actively involved with and participate in the W3 committee and the IMS standards body.

See [Appendix J – Manifests, SCOs and Metadata: SCORM Implementations of AFIADL Instructional Modules](#) for information about the relationship among SCORM Manifests, Resources and Metadata.

2.2 Develop Metadata Tagging Protocol

Task 3.1.2 Description: Develop a metadata tagging protocol, using the results from the taxonomic study.

See [Appendix D – AFIADL Metadata Master](#) to view the final metadata fields defined during this project.

See [Appendix J – Manifests, SCOs and Metadata: SCORM Implementations of AFIADL Instructional Modules](#) for information about the relationship among SCORM Manifests, Resources and Metadata.

Task 3.1.3 Description: Evaluate the taxonomies' and the derived metadata's abilities to support usage within and across content communities.

This task studied the current training development workflow and creating metadata as part of the workflow.

See [Appendix I - Roles and Responsibilities Involved in Conversion of the Maintenance Data Systems Analysis Course](#) for an overview of the workflow process based on Teleologic's project converting an AFIADL CDC to a NBL form, known as an eCDC.

Task 3.2 Description: Develop documentation that describes business rules, processes, guidelines, and workflows for content development and metadata

tagging. The Maintenance Data Systems Analysis Course will serve as the primary source of information for this work; however, additional CDCs may be added to help assure the generalizability of the derived workflows, processes, roles, responsibilities, and tools.

See [Appendix F - AFIADL 2A351v3ul RIM Metadata: F-15/A-10/U-2 Avionic Systems Journeyman, Volume 3. Electronic Principles, Unit 1, Basic Electronics](#) to view the metadata fields for this particular course.

See [Appendix G – Classification Fragment Domain.xml](#) for insight into the xml structure that was the basis for some discussion on coding classifications.

See [Appendix E – Metadata XML](#) to view the XML form of the metadata.

See [Appendix H – Supporting Searching using Metadata](#) for more detail about the metadata and the discovery methods that serve the discovery process.

2.3 Evaluate AFIADL Repository

Task 3.1.5 Description: Evaluate the search engines in the AFIADL Repository (formerly known as JMEANS Repository—GOTS software) and the AFIADL Learning Center (based on the Meridian Knowledge Center—COTS software) to effectively use the metadata derived from this study.

Boeing coordinated with AFIADL to gain access to the current repository, JMEANS and the Learning Center. While the Learning Center is a COTS tool and has a nice looking and performing user interface, the campus paradigm it uses is intuitive to some but confusing to others that do not have (or remember their) experience at a college campus. Since this is a Learning Management System (LMS) serves a different purpose to a different user group than JMEANS. Specifically, the Learning Center is concerned with allowing students to find, register for, and take course while JMEANS is concerned with allowing developers to find and reuse content that is used for those courses. Therefore, a Learning Center search only searches for courses whose title or description contains the search criteria whereas a repository search may involve many more fields.

To integrate the metadata editing screens and for studying the effectiveness of the metadata taxonomies, Boeing created a development version of selected portions of the JMEANS database. A dataset was provided to populate the database. In analyzing the database, Boeing discovered that many tables and metadata fields were not populated. Evidently the tool that was supposed to populate the SCORM metadata fields is presently disabled.

Boeing has had several occasions to review Learning Content Management Systems (LCMSs). These systems include a repository to contain learning content. While many provide LMS capabilities, all have mechanisms to provide configuration management, and most provide limited content authoring and assembly. Boeing advocates the use of an LCMS to manage learning content development throughout the lifecycle of the content. Therefore, the evaluation of LCMS' focus on the capabilities for managing the actual development, testing,

integrating, and updating of the content as well as the workflow of those stages. Boeing's review found the current JMEANS system to be inefficient and lacking some key functionality when compared to LCMSs. When examining the code and database structure, Boeing found that JMEANS is not able to scale well (expand).

The 5 general areas of LCMS capability evaluated are:

1. Content Creation
2. Content Management
3. Publishing
4. Presentation
5. Company Support

Boeing interviewed some users of the repository, to gain a better understanding of how the repository was actually used: the frequency of use, what types of content are stored and reused, and how the tool is currently used during the workflow of training development. The repository is not currently being used in production, so neither of the two recommended contacts were production users of the repository. One person, who's group was tasked with testing the repository, and had uploaded objects and performed basic searches as part of testing, but had not had the need to download any of the currently loaded objects for reuse. We discovered they were not using the keyword fields—rather, they made sure any desired keywords were in the object description. This verified our assumption that entering metadata needs to be a fast and easy process, with as many metadata fields as possible automatically populated during the normal workflow.

See [Appendix K – Evaluation of the AFIADL ADL Object Repository](#) for more information concerning the evaluation of the repository. This appendix contains a detailed checklist of 24 features used by Boeing to evaluate Learning Content Management Systems (LCMS).

2.4 Review COTS Metadata Editors

Task 3.2.5 Description: Using the business rules, processes, guidelines, and workflows for content development and metadata tagging, evaluate existing COTS software for meeting these requirements. Define, as necessary, any required extensions.

Several factors were used for evaluation of metadata editors for this project:

- Ease of Use – User interface that makes data entering a form-filling task.
 - Maximizes use of drop down, checkbox, and radio button selections
 - On-line help with examples in same window or tooltip for every field
 - Supports choice of templates

- Ability to customize taxonomy
- Support of Automation
 - Custom defaults
 - Set values of data fields based on values of other fields and other parameters such as user name
 - Populating fields based on imported metadata and information extracted from object itself (e.g. image size of graphic files, author of MS Office files)
- Support of Metadata Standards/Specifications and Profiles
 - IEEE LOM, IMS MD, SCORM 1.2 SCORM 2004 profiles
- Ability to Integrate into other Repositories
 - Web-based, stand-alone, integrated with LMS/LCMS/CMS/other
- Cost, Licensing, and System Requirements

Several COTS products provide efficient metadata editing and few met the requirements. However, none of these products could be integrated into the repository cost-effectively. The products were either XML document editing tools or were integrated with existing LCMSs and none were web-based so each required a license for the XML editor or the LCMS on each client computer.

See [Appendix M – Review of COTS Metadata Editors](#) for a detailed description of the COTS tools evaluation.

2.5 Develop Metadata Database Schema

Task 3.1.4 Description: Using the results from this study, develop a database or repository schema, develop a SCORM compliant schema for implementing Metadata.

Since the evaluation of the current AFIADL repository, JMEANS, revealed that so many of the metadata fields were not populated, it was more efficient to create new tables for the Metadata Tool. Boeing attempted to use JMEANS where it was efficient and appropriate.

See [Appendix N – Metadata Editor Prototype](#) for a description of the rationale for creating the new tables.

See [Appendix L – Metadata Database Schema](#) for a proposed database schema which is more efficient and can support multiple schemas.

2.6 Develop Metadata Editor Prototype

Task 3.1.8 Description: Using the metadata tagging protocol, define and evaluate existing commercial off-the-shelf (COTS) software, and prototype, as necessary, a metadata tagging tool. At a minimum, this tool will support consistent, within and across content community usage of metadata using capabilities such as database forms driven by drop down entry boxes and lists.

The original task was to develop a prototype of a Metadata Tagging Tool. This task evolved to include the capability to edit existing metadata and search for content using metadata. The current Metadata Tool incorporates the original function of the Metadata Tagging Tool, as well as a Metadata Editor and Metadata Search Tool.

Boeing used the taxonomy defined by Teleologic and found where the taxonomy “fit” in the SCORM, IEEE and IMS Metadata definitions. The Metadata Tagging Tool is designed to support SCORM, IEEE and IMS Metadata.

The major design guideline was to put all of the metadata information in front of the user—although it may be overwhelming at first, the user does not have to search for the information. This design guideline was met with a form-based editor, where the user does not have to understand the metadata or metadata structure—just fill in the form.

The original prototype was integrated into the existing system (JMEANS) using the new tables.

Boeing is delivering a database schema, population database, population script and ColdFusion web pages. Boeing will provide a CD that may be installed at the customer site. The Metadata Editor Prototype is for evaluation only, and is not intended to be a production-ready tool.

See [Appendix N – Metadata Editor Prototype](#) for detailed information about the Metadata Tagging Tool user interface.

2.7 Develop Documentation

Task 3.4 Description: Develop final report summarizing first-phase project findings, evaluations and field-testing results, and recommendations.

This Final Report includes all of the major technical documents delivered as part of this contract (see appendices). Some of the documents have been previously delivered. Monthly reports, non-technical meeting minutes and postings from the online forum are not included here.

2.8 Evaluate the Metadata and Metadata Editor Prototype

The evaluation of the metadata and the Metadata Editor Prototype occurred after the prototype was installed and interfaced with the JMEANS repository. Boeing assisted with the Metadata Editor Prototype installation for the field test and evaluation. Teleologic provided a document with instructions for the participants of the field test. See [Appendix O – AFIADL Searching Efficiency: Instructions to Participants](#) to view the instructions. The individual files for the Repository Objects and Metadata for the Evaluation are also included in the accompanying appendices (O.1-O.10).

The Evaluation was a small study was made of the use of the metadata fields developed by the AFIADL Taxonomy Working Group (TWG). Six users attempted to find a target resource using a prototype online search tool developed by Boeing. The principal objective was to determine which fields the users favored. Of the 26

unique fields, 5 were found to result in 50% of the use. 80% of the use was restricted to 12 fields. The success rate was not high, owing to multiple factors associated with the prototype status of the tool and the limited data set size. Since the objective of this evaluation was to explore the use of available fields, this did not constitute a major problem. In fact, the difficulty in achieving successful results produced an abundance of instances for analysis.

It is necessary to consider that the data represent the activities of a small number of participants, thus the conclusions should not be considered conclusive, only indicative. This test was an evaluation of the amount that searchers would use the fields developed by the taxonomy working group. It was not a test of the tool itself. The difficulties with the metadata tool and the small object data set resulted in a large number of attempts from participants. This produced a large data set for analysis from a small population. A small number of searchers (6) created a large number of searches (257), averaging 42.8 searches per searcher. Optimization of the tool user interface should be a subject of future work.

See [Appendix P – AFIADL Metadata and Taxonomies Evaluation](#) for a detailed description of the Evaluation.

3. Recommendations

The current JMEANS database structure is not highly compatible with flexible metadata recording and storage structure.

Recommendations:

1. Make the metadata separate from the object repository—they are conceptually two different things. The metadata is a key into the object repository. The object repository is not designed to be a descriptive search tool.
2. Integrate the Metadata Tool into the course development workflow and make the existing Metadata Tool prototype “production-ready” for potential use by multiple service branches as both a standalone and an online tool integrated with a repository.
3. Automate the population of as many metadata fields as possible.
4. Eliminate free text entry fields where possible to avoid typos and the use of keywords outside the defined taxonomy.
5. Develop a way to abstract and connect to other taxonomies and catalog systems. Need a central authority or an abstraction of all the taxonomies to improve performance, reuse and common interoperability.
6. Develop administrator tools.
7. Add the capability to import and export the object’s metadata to and from other repositories. The export capability should yield SCORM-conformant metadata.

8. Add ability to use other metadata schemas or the ability to customize the metadata schema for a particular use or user, i.e. the Navy. Another branch of the military could use the tool by customizing the metadata schema to their requirements.
9. Add ability to restrict access with permissions to object metadata, such as view and edit functions.
10. Optimize the database tables.

4. Appendices

The appendices include all of the major technical documents delivered as part of this contract. Some of these documents have been previously delivered as part of this contract.

NOTE: For a full copy of this report, including appendixes, please contact AFIADL at DSN 596-1356 or commercial (334) 416-1356.